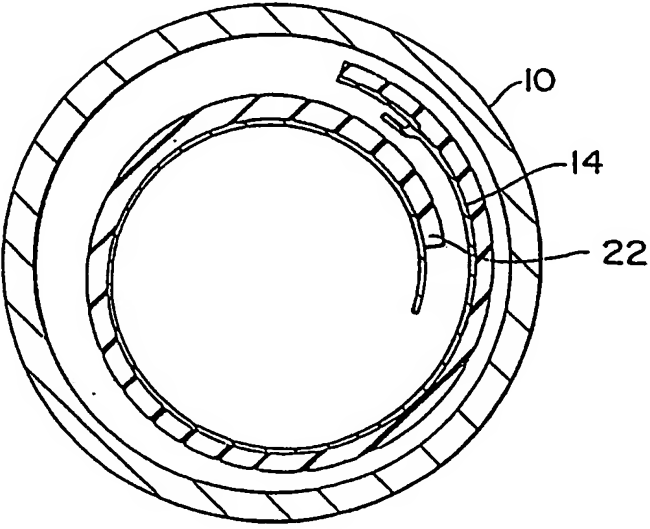


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(21) International Application Number: PCT/FI89/00199 (22) International Filing Date: 27 October 1989 (27.10.89) (30) Priority data: 264,376 31 October 1988 (31.10.88) US (71) Applicant: LAHTI, Heikki [FI/FI]; Untamontie 2, SF-01420 Vantaa (FI). (71)(72) Applicants and Inventors: MAIMETS, Lembit [CA/CA]; 39 Rivercourt Blvd., Toronto, Ontario M4T 3A3 (CA). MEADUS, Warwick [CA/CA]; 4216 Treetop Cr., Mississauga, Ontario L5L 2L9 (CA). (74) Agent: VANTAAN PATENTITOIMISTO HEIKKI LAHTI; Kalevankatu 44 A 14, SF-00180 Helsinki (FI).		(81) Designated States: AT (European patent), BE (European patent), BG, CH (European patent), DE (European patent), DK, FI, FR (European patent), GB (European patent), HU, IT (European patent), LU (European patent), MC, NL (European patent), NO, RO, SE (European patent), SU. Published <i>With international search report.</i>
(54) Title: INTERNAL PIPE REPAIR SLEEVE AND LINER  (57) Abstract <p>A pipe repair sleeve and liner with interlocking elements in a form of a coiled sheet which is covered with compressible gasket. An air bag is inserted into the coiled sleeve and moved to the location of the damaged pipe. Once in place, the air bag is inflated. As a result of the inflation, the repair sleeve uncoils and the surrounding gasket is compressed against the damaged pipe. When the air bag is deflated, the sleeve begins to coil and forces a male end of the sleeve into the female end forming a male and female interlocking continuous sleeve inside the pipe. After the repair sleeve is installed in the pipe, the air bag is removed from the sleeve.</p>		

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INTERNAL PIPE REPAIR SLEEVE AND LINER

BACKGROUND OF THE INVENTIONField of the Invention

The present invention generally relates to a pipe repair sleeve and method of repairing pipes, tunnels, conduits and other similar structures as well as to a method for repairing underground pipes by inserting an expandable sleeve inside the pipe and expanding the same to seal a damaged or leaking portion of the pipe.

DESCRIPTION OF BACKGROUND AND MATERIAL INFORMATION

Conventionally underground pipes, tunnels, conduits and similar structures may be repaired in various ways.

One method involves forcing a sealing fluid into the pipe lining under the pressure through the damaged portion in the pipe.

Another method involves coating the interior of the underground pipe with a sealing material in order to repair the damaged portion of the pipe.

Other conventional methods include procedures wherein a rigid pipe is installed within an existing pipeline and wherein sleeving elements are used in order to expand the same against the inner part of the underground pipes.

British Patent 2,136,912, BARRY, discloses a method of sealing pipes having a sleeve impregnated with a curable resin which is placed around an inflatable and collapsable bag. The sleeve and bag are attached to a pulling line and introduced into the damaged part of the pipe. The bag is inflated thereby expanding the fiber glass laminate sleeve into pressure contact with the inner wall of the pipe. After the resin hardens, the bag is collapsed and moved.

U.S. Patent 4,589,447, CANE et al., discloses a method of inserting a coiled element into damaged tunnel or conduit. When the coil element is positioned at a damaged location, the coil element unwinds and expands outwardly forcing the sleeve on its outer surface against the wall of the conduit and seals the damaged portion of the tunnel.

U.S. Patent 4,581,801, KOBUCK et al., discloses a method which uses a metal sleeve 16 and an expander element 24 which are both inserted into a pipe. The expander element causes a sleeve to expand against the inner surface of the tube.

U.S. Patent 4,347,018, WRIGHTSON et al., discloses a method of repairing the lining of tunnels, conduits and the like wherein an overlapped pipe is inserted into the tunnel. The steps holding the pipe in its hold-up state are released forcing the pipe to extend.

U.S. Patent 4,361,451, RENAUD, discloses a lining arrangement wherein a lining sleeve and inflatable envelope having a layer of resin therebetween are introduced into a conduit. The envelope is inflated and forces the sleeve against the inner wall of the conduit.

None of these prior art arrangements, however, discloses the pipe repair apparatus and method, in accordance with the present invention, as disclosed and claimed in more detail hereinbelow.

SUMMARY OF THE INVENTION

Accordingly, it is a general object of the present invention to provide a new and improved pipe repair sleeve and method of repairing underground pipes, tunnels, conduits and other similar structures.

Another object of the present invention is to provide a new and improved underground pipe repair method which minimizes the labor required and the necessary time for repairing the same.

A further object of the present invention is to provide a new and improved internal pipe repair sleeve which expands and locks in position inside the pipe structure to seal a damaged or leaking part of the pipe.

These and other objects of the invention are achieved using a coiled repair sleeve having edges with locking members which is expanded, for example, by means of an air bag inserted into the coil of sheet material, covered with

elastic gasket material, which forms the sleeve. The repair sleeve with the air bag inserted is moved to the location of the damage or leak; upon reaching the site of the damage, the air bag, or other means of expansion, is inflated or otherwise expanded so as to uncoil the sleeve and compress the gasket material against the inside of the pipe. When the air bag is then deflated, the uncoiled sleeve retracts to a certain degree due to its spring-type property and the elasticity of the gasket material. As this happens, the male locking member of the sleeve slips into the groove of the female locking member of the sleeve to form a continuous interior sleeve inside the pipe. After deflating, the air bag is removed from the pipe structure.

Thus, the present invention is directed to a generally elongate member with interlocking longitudinal edges including a sheet of material having two longitudinal edges, and means for locking associated with the longitudinal edges adapted to fasten the longitudinal edges of the sheet together to form the sheet into a generally tubular configuration, wherein the sheet is composed of flexible material, preferably selected from the group consisting of metal and plastic, and more preferably metal, and preferably wherein the sheet is coiled. The means for locking includes a male locking member and a female locking member adapted to mate with the male locking member.

Preferably the male locking member includes an elongate element having a predetermined length and the female locking member includes an outer lip having a length substantially equal to the length of the male locking member and an inner lip having a length shorter than the length of the length of the outer lip.

More particularly, the present invention is directed to a pipe repair liner including a sleeve having an outer surface, having a structure substantially as described above, provided with a covering on at least a portion of the outer surface of the sleeve wherein the covering is composed

of a compressible material, preferably selected from the group consisting of plastic and rubber, wherein the plastic is a plastic foam, such as polyethylene foam. Preferably the covering is a gasket, and preferably the exterior surface of the outer lip of the female locking member is covered with the gasket material.

In a preferred embodiment, the present invention is directed to a pipe repair apparatus including a sleeve in the form of a coil which is provided with a covering on at least a portion of the outer surface of the sleeve having a structure substantially as described above, in addition to means for expansion inserted in the coil adapted to compress the covering against the inside of a pipe into which the pipe repair liner is placed, preferably wherein the means for expansion is an expandable air bag which may be pleated.

In addition, the present invention is also directed to a method of repairing pipes, tunnels, conduits, or similar structures having damaged sections in the form of cracks, leaks, holes, or eroded surfaces and the like which involves providing a pipe repair apparatus, as described above, inserting the pipe repair apparatus in a pipe; expanding the means for expansion to uncoil the sheet of coiled material to compress its covering or gasket against the inside of the pipe; retracting the means for expansion to permit the locking members associated with the longitudinal edges of the sheet to lock the sheet into a rigid tubular configuration lining the pipe.

BRIEF DESCRIPTION OF DRAWINGS

The above and other objects, features and advantages of the present invention are detailed hereinafter with respect to the accompanying drawings, in which like reference characters are used to describe corresponding parts throughout the several views, and wherein:

Fig. 1 is a cross-sectional view in elevation of a sleeve member in partially expanded position;

Fig. 2 is a cross-sectional view in elevation of the sleeve member in the expanded and interlocking position;

Fig. 3A is a cross-sectional view of the sleeve member in partially expanded position;

Fig. 3B is a cross-sectional view of the sleeve member wherein a male edge is snapped into female edge position;

Fig. 3C is a cross-sectional view of the sleeve member in complete interlocking engagement;

Fig. 4A is a cross-sectional view of welded female edge of the sleeve member;

Fig. 4B is a cross-sectional view of stamped and welded female edge of the sleeve member;

Fig. 4C is a cross-section view of stamped female edge of the sleeve member;

Fig. 4D is a cross-sectional view of rolled female edge of the sleeve member;

Fig. 4E is a perspective view of female and male edges with a line of slots and studs respectively;

Fig. 4F is a cross-sectional view of the embodiment of Fig. 4E;

Fig. 5 is a perspective view of internal pipe repair sleeve in the form of a coiled sheet;

Fig. 6 is an end-view in elevation of the partially inflated air bag inserted into the sleeve;

Fig. 7 is a schematic view of air bag and pressure source;

Fig. 8A is a perspective view of internal pipe repair sleeve and liner with the air bag in deflated position inserted into the damaged sleeve;

Fig. 8B is a perspective view of internal pipe repair sleeve in expanded position with inflated air bag in the damaged pipe;

Fig. 8C is a perspective view of internal pipe repair sleeve in the complete interlocking engagement forming a continuous interior sleeve inside the damaged pipe; and

Fig. 9 illustrates the installation process of internal

pipe repair sleeve and liner in the damaged pipe at location of damage or leak.

DETAILED DESCRIPTION OF THE DRAWINGS

The present invention will now be described in greater detail with reference to the embodiments illustrated in the drawings.

More specifically, Fig. 1 illustrates the sleeve 14, preferably made of material which is elastic or tensioned, such as metal, to form a spiral, coil or spring-type structure. The sleeve is covered by a compressible material 22, the compressible covering material is preferably in the form of a gasket, made of plastic, rubber or other elastic material such as plastic foam, eg. polyurethane foam. As shown, sleeve 14 and gasket 22 are inserted in the pipe 10.

Fig. 2 shows the structure of sleeve 14 with its longitudinal edge locked in position to compress gasket 22 tightly against the interior wall of pipe 10.

A cross-section of the male-female interlocking arrangement of the pipe repair sleeve 14 is illustrated in Figs. 3A, 3B and 3C. As shown in Fig. 3A, the longitudinal male locking member 24 has an exterior surface which is exposed or uncovered by the material of gasket 22 over a portion of its length which corresponds to female locking member 26 having an exterior surface which is covered by compressible gasket 22. In another embodiment the gasket 22 can be continued throughout the entire length of the male locking member 24. Although the thickness of the gasket material can be substantially the same over the entire exterior surface of the sleeve member, if the exterior surface of the male locking member is covered, the gasket material is preferably thinner than the cover over the other portions of the exterior surface of the sleeve member and is designed primarily to ensure water tightness, preferably utilizing easily compressible material such as low density polyethylene foam or foam rubber. In order to allow for the engagement of the male locking member 24 and the female

locking member 26, a wider female groove than otherwise would be required is utilized where the outer surface of the male locking member is covered with the gasket material. As shown, the female locking member includes an outer lip having a length, substantially corresponding to the uncovered portion of the male locking member having the previously mentioned exterior surface 26 covered by the gasket material and an interior or lower lip 28 which is preferably shorter in length than the length of the outer lip. As a result of the pressure by the air bag or other means for expansion, the sleeve 14 is expanded to an oversized configuration i.e: wherein the male locking member slides over the interior surface of the lower lip to a point beyond the edge of the lower lip. When the air bag is deflated, the sleeve 14, due to its spring-type property, coils so that male locking member 24 of the sleeve 14 is snapped into a groove of female locking member 26 of the sleeve as shown in Fig. 3B. After the deflation is completed and the air bag removed from the sleeve, male locking member 24 and female locking member 26 of the sleeve 14 are completely interlocked forming a continuous sleeve inside the pipe 10, as shown in Fig. 3C.

Alternative structural embodiments of the female locking member of the sleeve 14 are illustrated in Figs. 4A, 4B and 4C. As shown the female locking member end in a form of a groove can be welded as shown in Fig. 4A, stamped as shown in Fig. 4C, or stamped and welded as illustrated in Fig. 4B or rolled as shown in Fig. 4D.

Fig. E illustrates an embodiment wherein the female edge has a series of slots 25 and male edge with a series of protrusions in the form of hooks or studs 27. This embodiment is particularly preferred where one wishes to have the edges of the sleeve member fastened together. Thus, the stud-slot fastening assembly can be used in the embodiments described herein where the elongate male member engages within the groove of the female member, or may be

the sole means for interconnecting the edges of the sleeve to hold the same in a tubular configuration once the force of expansion is released. Thus, when the air bag is inflated the male edge 24 uncoils and aligns with female edge 26 so that the series of protrusions hooks or studs slip into a series of slots. When the air bag is deflated the protrusions 27 are hooked in the slots 25 and remain firmly engaged in a locking position.

A cross-section of female male edges with slots 25 and protrusions or studs 27 respectively is shown in Fig. 4F.

Fig. 5 shows a pipe repair sleeve 14 in a form of coiled sheet made of metal or any other rigid material capable of being tensioned into a spring, spiral or coil. The exterior surface of the sheet is covered with a covering 22 made of plastic rubber, or other compressible material which is preferably elastic, to function as a gasket. The gasket may be made of any elastic material such as plastic or rubber, but is preferably made of polyethylene foam.

Fig. 6 illustrates the prepared means for expanding the sleeve 14. As shown, an air bag 12 is inserted into the coiled sleeve 14; air is introduced through a hose 11 which inflates the air bag and which expands to compress against the interior of sleeve 14 which uncoils the sleeve. The structure of air bag 12 with pleated sides is shown in schematic in Fig. 7A and the structure of expandable plastic bag-or balloon like configuration 15 is shown in schematic in Fig. 7B.

The method of repairing underground pipes, tunnels, conduit or similar structures is illustrated in Figs. 8A, 8B, 8C and 9. Fig. 9, illustrates the pipe repair sleeve 14 with inserted air bag (not shown) at location A is moved to the damaged pipe 10 through existing man hole or in its absence excavated hatch MH1. The sleeve is inserted into the end of the pipe 10 at location B. In order to assist in the detection of the place of damage or leak, a TV or equivalent camera 13 is placed in front of the sleeve 14.

damage or leak at 20. Once the sleeve 14 has been positioned at the place of damage 20, as shown in Figs. 8a and 9, the air bag 12 which can be smooth and expandable is inflated to expand against the interior and coil the sleeve as shown in Fig. 8b. As discussed above, Fig. 8c illustrates the pipe repair sleeve wherein the air bag is deflated; removed from the sleeve; and the male and female ends of the sleeve are completely interlocked performing a continuous interior sleeve inside pipe 10. The air bag removed from the sleeve and TV camera 13 are both removed out by the cable 16 through man hole or hatch MH2 using winch 18 as illustrated in Fig. 9.

From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention and, without departing from the spirit scope thereof, can make various changes and modifications of the invention adapted to various usages and conditions.

WHAT IS CLAIMED IS:

1. A generally elongate member with interlocking longitudinal edges comprising:

a) a sheet of material having two longitudinal edges; and

b) means for locking associated with said longitudinal edges adapted to fasten the longitudinal edges of the sheet together to form said sheet into a generally tubular configuration.

2. The generally elongate member in accordance with claim 1 wherein said sheet comprises flexible material.

3. The generally elongate member in accordance with claim 2 wherein said flexible material is a material selected from the group consisting of metal and plastic.

4. The generally elongate member in accordance with claim 3, wherein said flexible material is metal.

5. The generally elongate member in accordance with claim 4 wherein said sheet is coiled.

6. The generally elongate member in accordance with claim 1 wherein said means for locking comprises a male locking member, and a female locking member adapted to mate with said male locking member.

7. The generally elongate member in accordance with claim 6 wherein said male locking member comprises a series of studs and said female locking member comprises a series of slots adapted to receive said studs.

8. The generally elongate member in accordance with claim 6 wherein said male locking member comprises an elongate element having a predetermined length and said female locking member comprises an outer lip having a leading end and length substantially equal to the length of the male locking member and an inner lip having a leading end and length shorter than the length of the outer lip.

9. The generally elongate member in accordance with claim 8, wherein said male locking member comprises a series of studs, and said female locking member comprises a

plurality of slots positioned on said outer lip in an area along its length between the leading end of said outer lip and the leading end of said inner lip adapted to receive said studs.

10. A pipe repair liner comprising:

a) a sleeve member having an outer surface, said sleeve member comprising:

i) a generally elongate sheet having two longitudinal edges; and

ii) means for locking associated with the longitudinal edges adapted to fasten the longitudinal edges of the sheet together to form said sheet into a generally tubular configuration; and

b) a covering on at least a portion of the outer surface of said sleeve member.

11. The generally elongate member in accordance with claim 10 wherein said sheet comprises flexible material.

12. The generally elongate member in accordance with claim 11 wherein said flexible material is a material selected from the group consisting of metal and plastic.

13. The generally elongate member in accordance with claim 12, wherein said flexible material is metal.

14. The generally elongate member in accordance with claim 13 wherein said sheet is coiled.

15. The generally elongate member in accordance with claim 10 wherein said male locking member comprises an elongate element having a predetermined length and a female locking member adapted to mate with said male locking member.

16. The generally elongate member in accordance with claim 15 wherein said male locking member comprises an elongate element having a predetermined length with an outer surface and said female locking member comprises an outer lip with an outer surface having a length substantially equal to the length of the male locking member and an inner lip having a length shorter than the length of the length of

the outer lip.

17. The pipe repair liner in accordance with claim 10 wherein said covering comprises a compressible material.

18. The pipe repair liner in accordance with claim 17 wherein said compressible material is selected from the group consisting of plastic and rubber.

19. The pipe repair liner in accordance with claim 18 wherein said plastic is a plastic foam.

20. The pipe repair liner in accordance with claim 19 wherein said plastic foam is polyethylene.

21. The pipe repair liner in accordance with claim 17 wherein said covering is a gasket.

22. The pipe repair liner in accordance with claim 21 wherein said portion of said outer surface of said sleeve member comprises said outer surface of said outer lip of said female locking member.

23. The pipe repair liner in accordance with claim 21 wherein said portion of said outer surface of said sleeve member comprises said outer surface of said male locking member.

24. The pipe repair liner in accordance with claim 23, wherein said covering on said outer surface of said male locking member is thinner than said covering on other portions of said outer surface of said sleeve.

25. A pipe repair apparatus comprising:

a) a sleeve member comprising:

i) a sheet of material having two longitudinal edges;

ii) means for locking associated with said longitudinal edges adapted to fasten the longitudinal edges of the sheet to form said sheet into a generally tubular configuration, said sleeve member being in the form of a coil;

b) a covering on at least a portion of the outer surface of said sleeve member; and

c) means for expansion inserted in said coil

portion of a pipe into which the pipe repair liner is placed.

26. The pipe repair liner in accordance with claim 25 wherein said means for expansion is an air bag.

27. The pipe repair liner in accordance with claim 26 wherein said air bag is pleated.

28. The generally elongate member in accordance with claim 25 wherein said sheet comprises flexible material.

29. The generally elongate member in accordance with claim 28 wherein said flexible material is a material selected from the group consisting of metal and plastic.

30. The generally elongate member in accordance with claim 29, wherein said flexible material is metal.

31. The generally elongate member in accordance with claim 25 wherein said means for locking comprises a male locking member, and a female locking member adapted to mate with said male locking member.

32. The generally elongate member in accordance with claim 31 wherein said male locking member comprises an elongate element having a predetermined length and said female locking member comprises an outer lip having a length substantially equal to the length of the male locking member and an inner lip having a length shorter than the length of the length of the outer lip.

33. The pipe repair liner in accordance with claim 25 wherein said covering comprises a compressible material.

34. The pipe repair liner in accordance with claim 33 wherein said compressible material is selected from the group consisting of plastic and rubber.

35. The pipe repair liner in accordance with claim 34 wherein said plastic is a plastic foam.

36. The pipe repair liner in accordance with claim 35 wherein said plastic foam is polyethylene.

37. The pipe repair liner in accordance with claim 33 wherein said covering is a gasket.

38. The pipe repair liner in accordance with claim 33

wherein said exterior surface of said outer lip of said female locking member is covered with said covering.

39. A method of repairing pipes, tunnels, conduits, or similar structures having damaged sections in the form of cracks, leaks, holes and the like comprising:

- a) providing a pipe repair apparatus comprising:
 - i) a sheet of coiled material having two longitudinal edges;
 - ii) means for locking associated with said longitudinal edges of the sheet adapted to form said sheet into a generally tubular configuration;
 - iii) a covering on at least a portion of an outer surface of said sheet; and
 - iv) means for expansion inserted in said sheet coiled material adapted to compress said covering against an internal portion of a pipe into which the pipe repair liner is placed;
- b) inserting said pipe repair apparatus in a pipe;
- c) expanding said means for expansion to uncoil said sheet of coiled material to compress said cover against the inside of the pipe;
- d) retracting said means for expansion to permit said sleeve to uncoil; and
- e) interlocking the means for locking associated with edges of the sheet to form said sheet into a rigid tubular configuration lining said pipe.

40. A method in accordance with claim 39 wherein said means for expansion is an air bag.

41. A method in accordance with claim 39 comprising inflating said air bag to compress the cover against the interior of the pipe.

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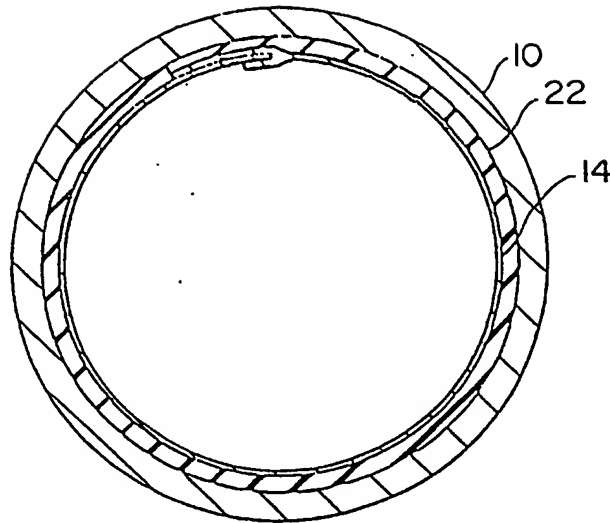


Fig. 2

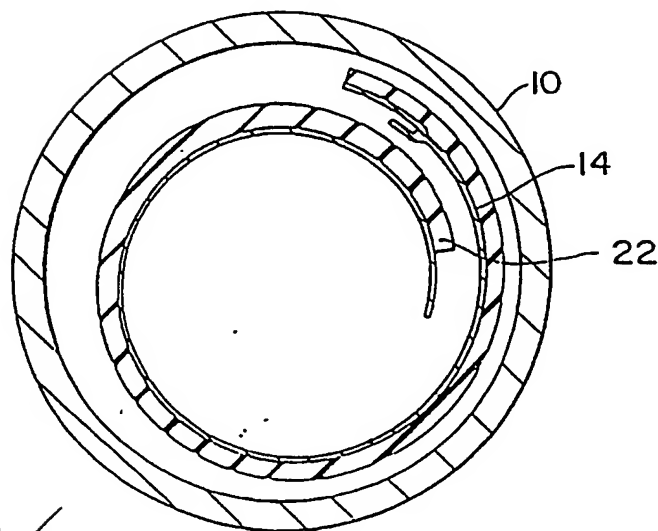
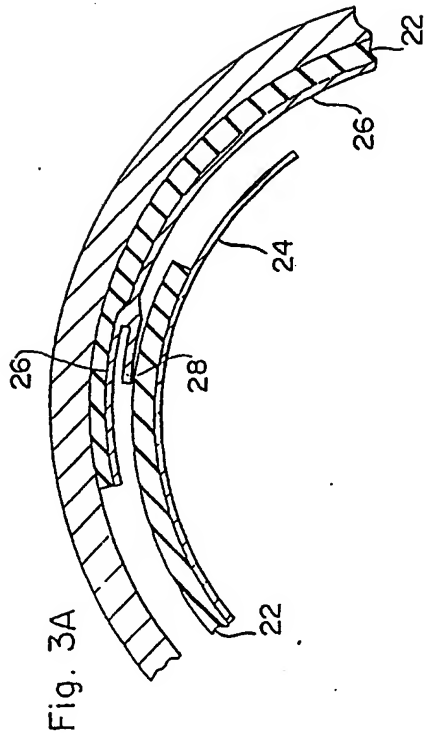
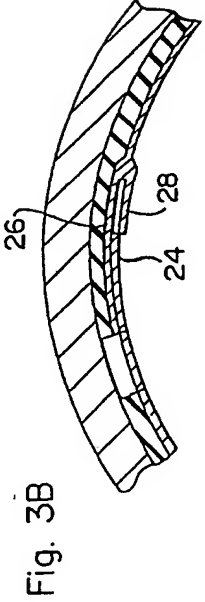
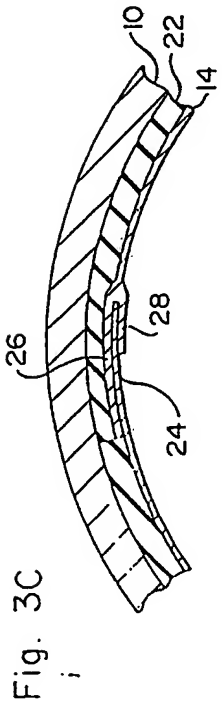
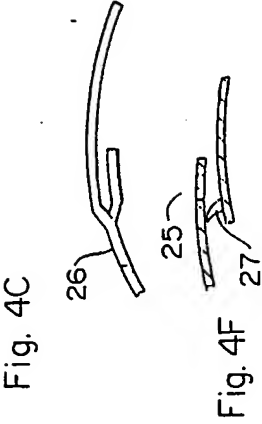
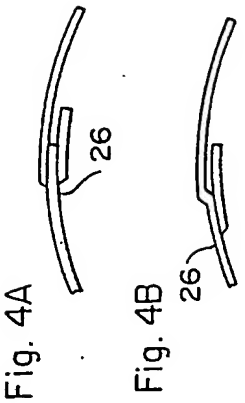
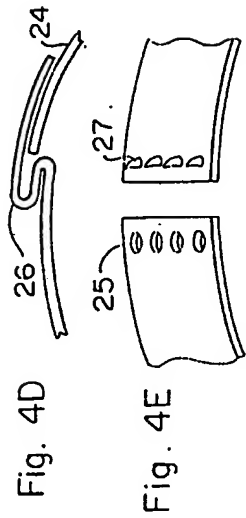
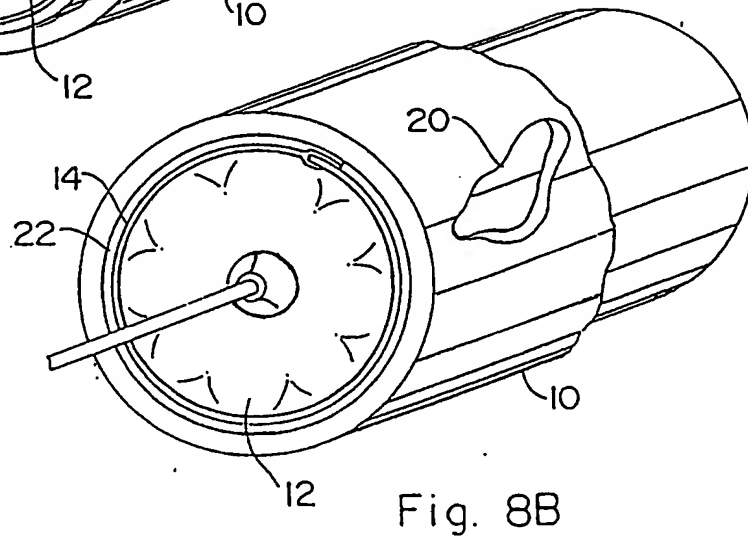
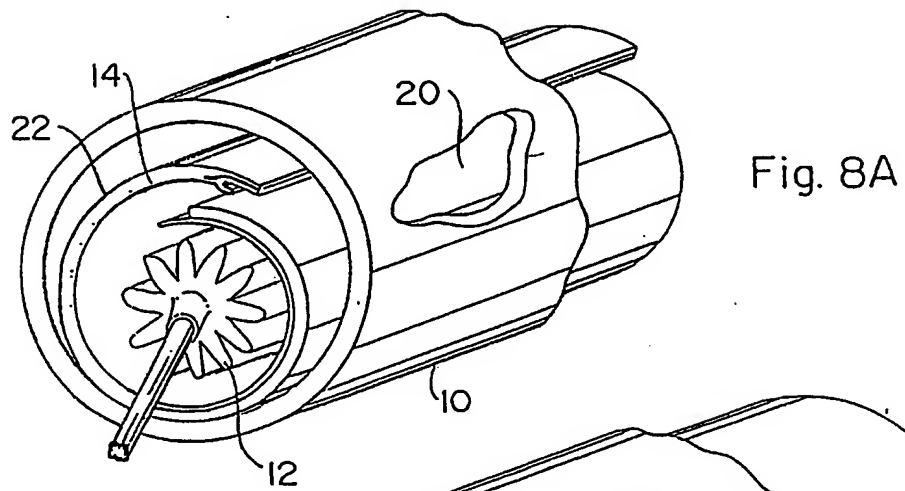
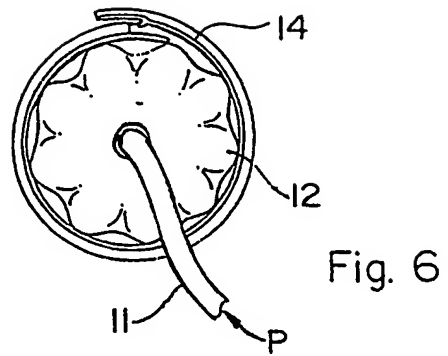
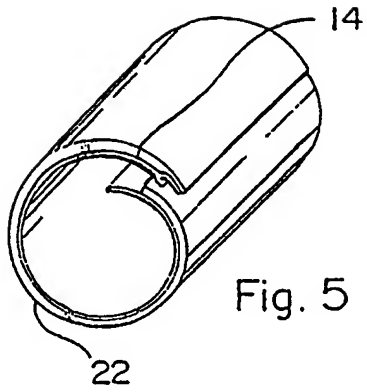


Fig. 1



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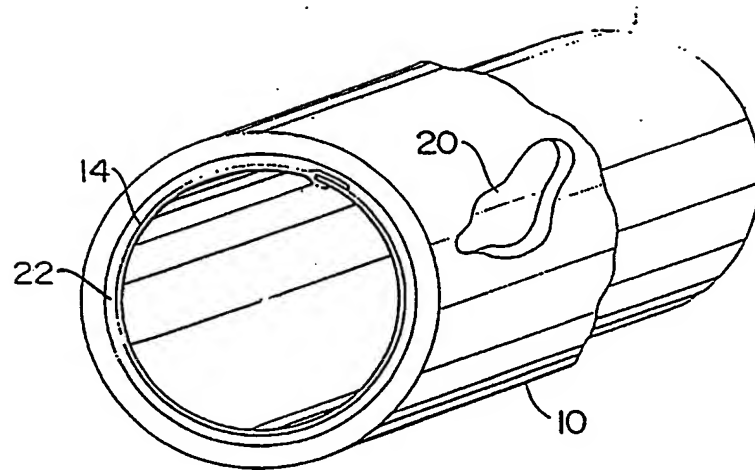


Fig. 8C

Fig. 7A

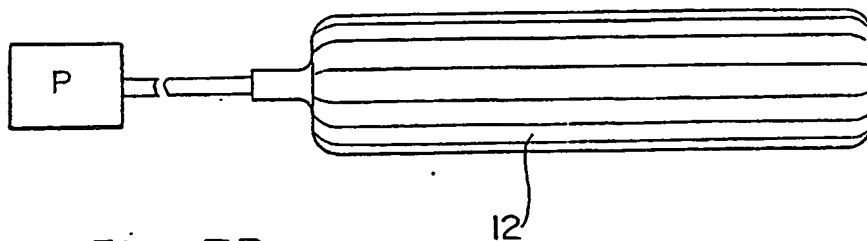
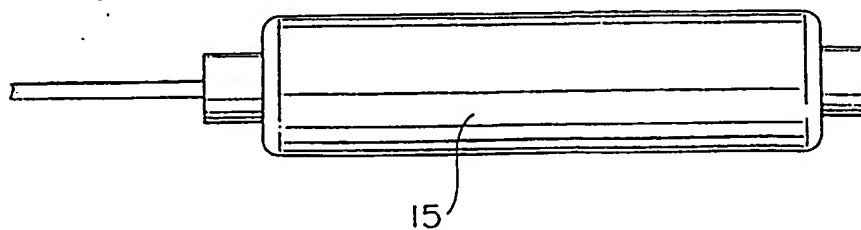
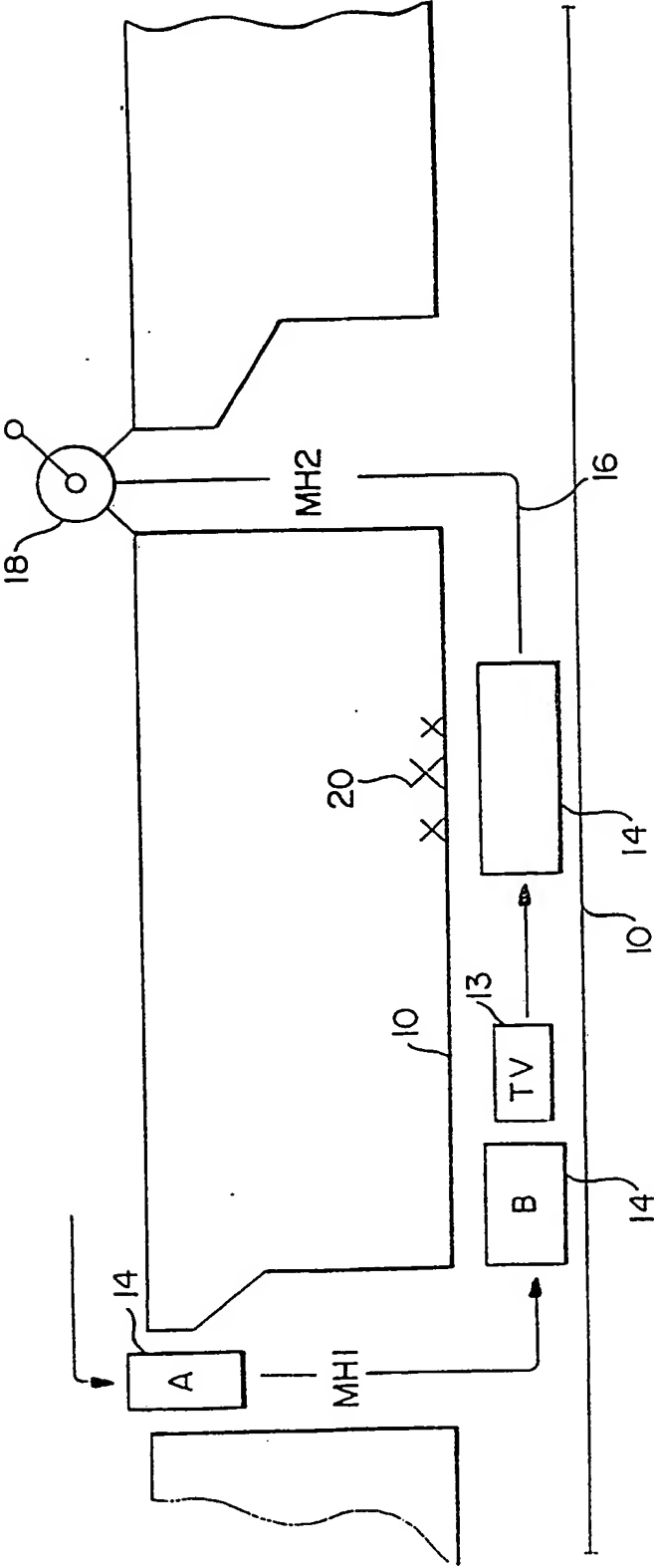


Fig. 7B



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Fig. 9



INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 89/00199

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: F 16 L 55/165		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification system ¹	Classification Symbols	
IPC5	F 16 L; E 03 F	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched ⁸		
SE,DK,FI,NO classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	US, A, 4767236 (RICE) 30 August 1988, see column 3, line 44 - line 54; column 4, line 3 - line 14; column 4, line 18 - line 23; column 4, line 27 - line 43	1-18,21- 34,37- 41
Y	--	19-20, 35-36
X	US, A, 3642032 (COOK ET AL) 15 February 1972, see column 3, line 74 - line 75; column 4, line 1 - line 21	1-18,21- 34,37- 41
Y	--	19-20, 35-36
X	US, A, 3678560 (DUFOUR ET AL) 25 July 1972, see column 2, line 16 - line 75	1-18,21- 34,37-41
Y	--	19-20, 35-36
<p>* Special categories of cited documents: ¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"Δ" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search 22nd January 1990	Date of Mailing of this International Search Report 1990 -02- 01	
International Searching Authority SWEDISH PATENT OFFICE	Signature of Authorized Officer Tommy Blomberg	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	EP, A1, 0015559 (TOKYO GAS CO. LTD, HAKKO CO. LTD) 17 September 1980, see page 5, line 18 - line 24; page 6, line 16 - line 26 -- -----	19-20, 35-36

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

The claims 1-9 state a generally elongate member.

The claims 10-24 state a pipe repair liner.

The claims 25-38 state a pipe repair apparatus.

The claims 39-41 state a method of repairing pipes, tunnels, conduits or similar structures.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☒ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
☐ No protest accompanied the payment of additional search fees.

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/FI 89/00199**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4767236	30/08/88	EP-A- 0251607 AU-D- 74636/87 JP-A- 63093991	07/01/88 24/12/87 25/04/88
US-A- 3642032	15/02/72	NONE	
US-A- 3678560	25/07/72	FR-A- 2091260 DE-A- 2122457 GB-A- 1315468	14/01/72 25/11/71 02/05/73
EP-A1- 0015559	17/09/80	JP-A- 55119286 JP-A- 55119288 JP-A- 55119289 JP-A- 55166588	12/09/80 12/09/80 12/09/80 25/12/80